



PIER Energy-Related Environmental Research

Environmental Impacts of Energy Generation, Distribution and Use

Assessing Impacts of Rangeland Management and Reforestation of Rangelands on Greenhouse Gas Emissions: A Pilot Study for Shasta County

Contract #: 500-02-004

Contractor: Applied Geosolutions, LLC

Contract Amount: \$3,043,107 (Full contract amount; only part funded this project.)

Contractor Project Manager: William Salas

Commission Project Manager: Guido Franco

Commission Contract Manager: Guido Franco

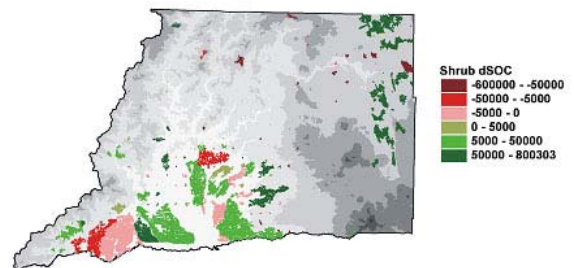
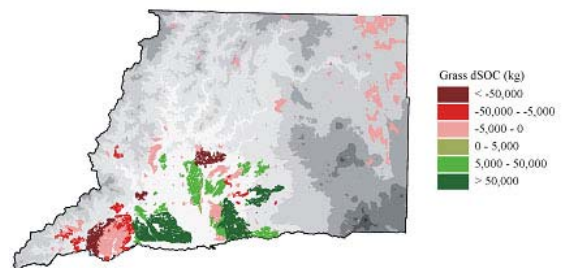
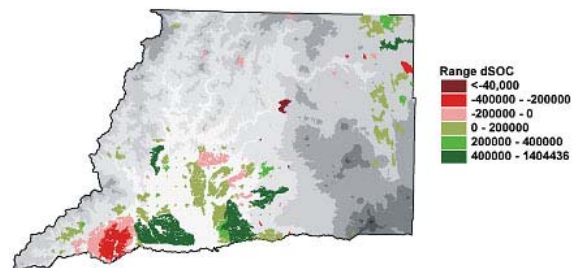
The Issue

To effectively respond to the growing threat of climate change, California will need to develop a comprehensive plan to reduce the greenhouse gases (GHG) emissions produced by energy production. The California Energy Commission's Public Interest Energy Research (PIER) program is funding research to determine and evaluate ways to offset GHG production through carbon sequestration in the soils of managed ecosystems.

Changes in land use can affect above- and below-ground carbon retention in the soil by affecting carbon and nitrogen dynamics and the release of GHGs. The conversion of forests into grasslands does not always respond uniformly to GHG emissions. Initial site quality and vegetation type can result in varied responses. Therefore, current land use strategies for mitigating GHG emissions from rangelands need to be studied in greater depth.¹

Project Description

Applied Geosolutions, LLC, in collaboration with the University of New Hampshire, conducted a study to design a framework that could be used to assess the effects of rangeland management and reforestation of rangelands on GHG emissions in Shasta County, California. This study used geographic information system (GIS) data on soils, climate, potential forest



Estimate of carbon sequestration in Shasta County rangelands. The top figure shows the net sequestration from annual grasslands, blue oak woodlands, and shrubs. The middle figure shows the contribution from annual grasslands, and the bottom figure shows the contribution from the shrub class. *Source:* Salas and Green 2007.

¹ Salas, W. and P. Green. 2007. *Assessing impacts of rangeland management and reforestation of rangelands on greenhouse gas emissions: A pilot study for Shasta county*. Applied Geosolutions, LLC for the California Energy Commission, PIER Energy-Related Environmental Research. CEC-500-2006-108.

type, and current rangeland types and forest/rangeland management as input for two soil biogeochemical process models: Denitrification-Decomposition (DNDC) and Forest-DNDC. A complete GHG balance was compiled for Shasta County for the 50 years following afforestation and compared with baseline model results to map changes in net GHG balance.

PIER Program Objectives and Anticipated Benefits for California

This project offers numerous benefits and meets the following PIER program objective:

- **Resolving environmental effects of energy production.** The proposed adaptation strategies of afforestation and reforestation of rangelands can be actively adopted and employed by land managers in the state to reduce GHG emissions over a multi-year time frame. This work benefits California by helping the state address the California Global Warming Solutions Act of 2006.²

Results

Researchers found that the annual carbon sequestration of the total rangeland area modeled is 5,640 metric tons of carbon per year, with all rangelands sequestering, on average, 29 kilograms of carbon per hectare per year (kg C/ha/yr). (The modeled area is represented by the colored areas in the figure; other rangelands were not modeled, because they were not suitable for afforestation.) The shrubs are a net sink for carbon, while Blue Oak and annual grasslands are net carbon sources, on average. The regional patterns of total carbon sequestration indicate that the annual grassland areas in the Southwest region of the county are losing carbon, whereas the other rangeland regions are predominantly sequestering carbon.

Sites with high soil carbon showed very little difference in modeled below-ground carbon retention in response to increased grazing intensity. However, grasses on areas with lower soil carbon had higher below-ground carbon retention in response to higher grazing intensity. This impact can also be seen in the magnitude of soil microbial respiration (release of carbon dioxide), as areas with lower initial soil organic carbon had an increase in respiration in response to the higher below-ground carbon allocation. In general, the DNDC model indicates that in the absence of grazing, rangelands of Shasta County would be sequestering ~50 kg C/ha/yr—an increase of 21 kg C/ha/yr over nominal grazing intensity. This is an increase of 4,390 metric tons of carbon per year.

The main goal of this project was to estimate how accounting for *all* the greenhouse gases affects the net benefit estimation of California rangeland afforestation. This research was conducted because some experimental studies suggest that increases in other GHGs (such as nitrous oxide and methane) may significantly reduce the net benefits of afforestation. This project's results indicate that, in general, a full emissions accounting of all GHGs adjusted carbon sequestration potential by less than 10%, suggesting that afforestation in California rangelands could result in a substantial net GHG reduction in the state.

Final Report

PIER-EA staff have posted the final report, *Assessing Impacts of Rangeland Management and Reforestation of Rangelands on Greenhouse Gas Emissions: A Pilot Study for Shasta County* on

² Assembly Bill 32, Nuñez, Chapter 488, Statutes of 2006.

the Energy Commission website: www.energy.ca.gov/2006publications/CEC-500-2006-108/CEC-500-2006-108.PDF.

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